Monitoring Report

'Building Capacity for Tree Conservation in Belize'

Global Trees Campaign Project

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Prepared for the Belize Forest Department

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Table of Contents

List of acronyms

BNR	Bladen Nature Reserve
DBH	Diameter at Breast Height
GSCP	Golden Steam Corridor Preserve
GTC	Global Trees Campaign
MGL	Maya Golden Landscape

Background

Forestry has long been a part of Belize's economic and social history and remains a major industry, yet little is known about many threatened timber and non-timber species in the country. While there is great capacity for forestry in Belize, the skills and actions required for tree conservation have been lacking from conservation and forest management organizations. In order to ensure sustainable use of tree resources and improved management of forests, information on tree species, such as distribution, population sizes and ecology, as well as the capacity of Belizean organizations to implement conservation actions need to be improved.

In 2013, Ya'axché Conservation Trust partnered with the Global Trees Campaign (GTC) to begin a 3-year project to build capacity for tree conservation in Belize. The development and implementation of this project was driven by the lack of information on both timber and non-timber species, a limited capacity of organizations to carry out conservation actions for tree species, and limited awareness amongst stakeholders of the threats facing trees within Belize. In order to address these needs the project consisted of three main branches: research and monitoring, capacity building (via stakeholder training) and awareness raising (via workshops for school and university students).

Target Species

A total of 19 species were chosen as target species for study based on their known rare or threatened status, a lack of information within Belize and/or the known use of the species for timber in Belize. Surveys revealed individuals of 7 species which were in a suitable location for monitoring (Table 1).

Table 1. Monitored target species and conservation status.

Species	Common Name	IUCN Red List Status
Dalbergia stevensonii	Rosewood, Honduran Rosewood	Not Assessed
Mortoniella pittieri	-	Not Assessed
Cymbopetalum mayanum	-	Endangered
Pouteria amygdalina	silion; silly young	Vulnerable
Chiangiodendron mexicanum	-	Endangered
Macrolobium sp.	-	Not Assessed
Platymiscium dimorphandrum	granadillo	Least Concern

Research and Monitoring

In order to implement conservation actions, knowledge of understudied species must be improved via research and monitoring. Outside of concessions (which focus on timber species) and general biodiversity inventories, little is known about the distribution, population size and ecology of many tree species. Assessing distribution and population size allows for implementation of conservation actions at the site level as well as an understanding of the number of individuals in Belize. Additionally, studying aspects of species

ecology such as habitat preference, phenology and dispersal can help to improve the knowledge of threats to species' persistence and regeneration.

A Ya'axché project in 2013 focusing on *Dalbergia stevensonii* (Honduran rosewood) included the location and tagging of individuals within the Golden Stream Corridor Preserve (GSCP) to be targeted for conservation action. Surveys for the additional target species were carried out as part of the GTC project in the Maya Golden Landscape (MGL, the focus area of Ya'axché's work) during 2014 and 2015 in order to gain an understanding of distribution, make an estimate of population size and improve ecological information for the species. These surveys were largely focused within GSCP and Bladen Nature Reserve (BNR), as these areas are under the management and co-management of Ya'axché, respectively. Individuals of species found within the two protected areas were chosen for repeated monitoring to assess trends in phenology (i.e. timing of fruiting and flowering periods) over the course of the project.

Methodology

In addition to the individuals of *D.* stevensonii located in GSCP in mid-2013, a total of 6 other target species were located during surveys in GSCP and BNR and were included in phenology monitoring trails. These species are: *Mortoniella pittieri*, *Cymbopetalum mayanum*, *Pouteria amygdalina*, *Chiangiodendron mexicanum*, *Macrolobium sp.* and *Platymiscium dimorphandrum*. These individuals were chosen based on the ease of access for repeat monitoring by Ya'axché Rangers.

GSCP Monitoring

One hundred individuals of *D. stevensonii* were tagged in 2013 in 4 different sites ('Hope Creek', 'Behind Greenhouse', 'Opposite Field Station' and 'Downstream') within GSCP (see Figure 1). Diameter at breast height (DBH) of the main stem for each tree was measured at 1.3m. The trees were classified in size classes of the following groups: Size Class 1: 5-10cm DBH, Size Class 2: 11-20cm DBH, Size Class 3: 21-30cm DBH, Size Class 4: 31-40cm DBH and Size Class 5: 41-50cm DBH.

Monitoring began in October 2013 and sites were visited once a week on a rotating basis (i.e. Week 1: Site A; Week 2: Site B, Week 3: Site C; Week 4: Site A, etc.). Trees at the 'Downstream' location were not monitored on the regular schedule due to the distance required for access. Therefore, these trees were only monitored 2-3 times per year during the project. During each visit a data sheet was filled out (see Figure 2) answering 'yes' or 'no' to questions relating to the phenological phase of each individual. Data was transferred to an Excel spreadsheet and analysed for general trends in flowering and fruiting.

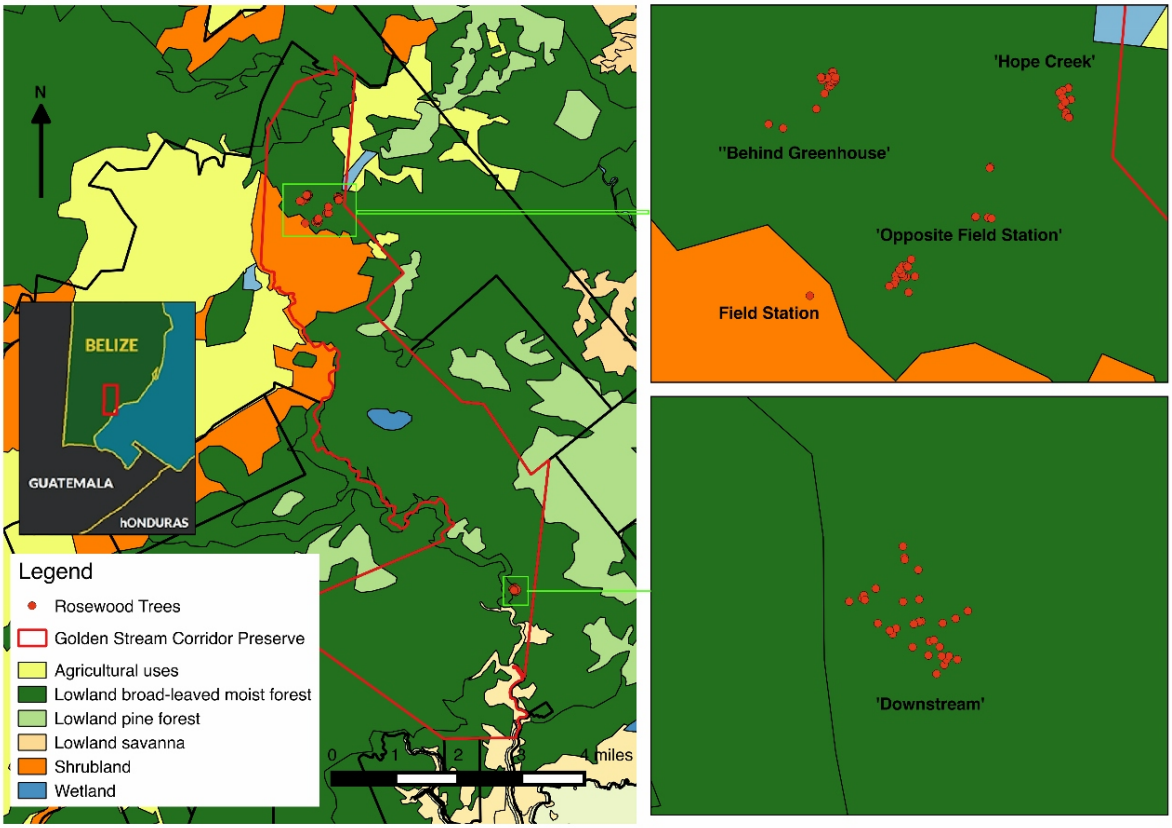

Figure 1. Location of 100 *D. stevensonii* trees monitored in GSCP.

Date Monitoring Carried Out:							
Ranger Names:							
		Is the tree losing its leaves?	Does the tree have flower buds (very small, green, hanging on ends of branches)?	Does the tree have open flowers on the branches or on the ground (look for pale yellow petals)?	Does the tree have unripe pods (bright green, hanging in clusters) on the branches?	Does the tree have ripe pods (brown) on the branches?	Are there pods on the ground?
		(yes or no)	(yes or no)	(yes or no)	(yes or no)	(yes or no)	(yes or no)
	Tag #						
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						

Figure 2. Data collection sheet for *D. stevensonii*.

BNR Monitoring

Individuals of 6 species were located in BNR during surveys and chosen for repeated phenological monitoring. A total of 34 individuals of the following species have been monitored since August 2014. *Mortoniella pittieri*, 11 individuals; *Cymbopetalum mayanum*, 5; *Pouteria amygdalina*, 11; *Chiangiodendron mexicanum*, 4; and *Platymiscium dimorphandrum*, 2. These individuals are located on a 'phenology trail' (see Figure 3) and are monitored once every 2 weeks. During each visit a data sheet was filled out (see Figure 4), answering 'yes' or 'no' to questions relating to the phenological phase of each individual. Data was entered into Excel and analysed for general patterns of phenology.

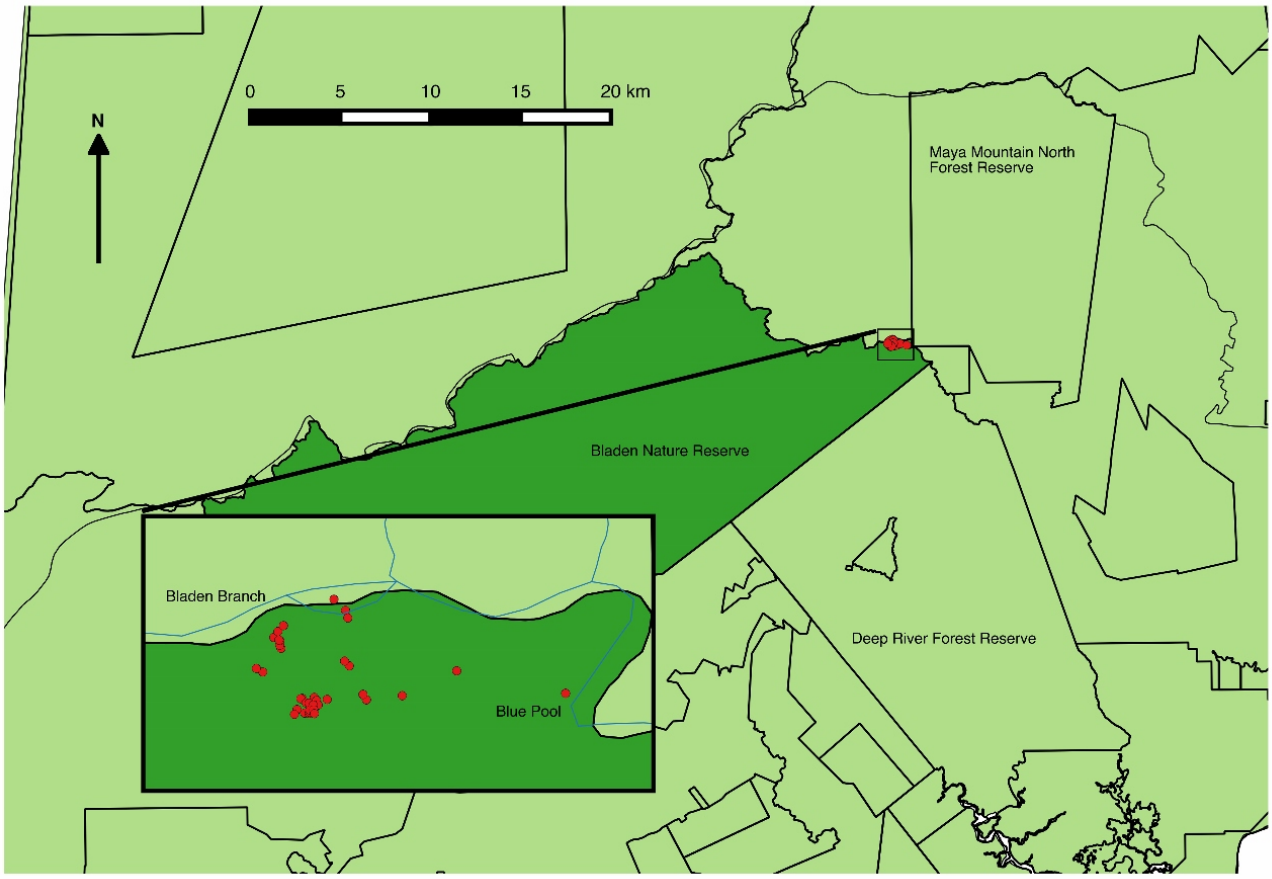

Figure 3. Location of target species (red points) monitored within BNR.

DATE MONITORING CARRIED OUT:								
RANGER NAMES:								
			Is the tree losing its leaves?	Does the tree have open flowers on the branches?	Does the tree have flowers on the ground?	Does the tree have unripe fruits hanging on the branches?	Does the tree have ripe fruits on the branches?	Are there fruits on the ground?
			(yes or no)	(yes or no)	(yes or no)	(yes or no)	(yes or no)	(yes or no)
Species	**WAYPOINT / TAG #**	**LOCATION**						
Mortoniella pittieri	1222	Main trail						
Cymbopetalum mayanum	1015	Main trail						
Cymbopetalum mayanum	1001	Main trail						
Cymbopetalum mayanum	1002	Main trail						
Cymbopetalum mayanum	1003	Main trail						
Pouteria amygdalina	1212	Slope plot						
Chiangiodendron mexicanum	1219	Slope plot						
Macrolobium sp.	1007	Slope plot						
Pouteria amygdalina	416	Slope plot						
Pouteria amygdalina	689	Slope plot						
Pouteria amygdalina	742	Slope plot						
Pouteria amygdalina	780	Slope plot						
Pouteria amygdalina	872	Slope plot						
Pouteria amygdalina	892	Slope plot						
Pouteria amygdalina	915	Slope plot						

Figure 4. Data Collection Sheet for trees monitored in Bladen Nature Reserve.

Results

GSCP

The *D. stevensonii* trees were monitored for a total of 121 days between October 2013 and March 2016, inclusive. The number of trees monitored in each size class is shown in Table 2. A total of 62 of the 100 trees were found with flowers and/or fruits at least once during the period of monitoring. All other trees were not observed to have fruited or flowered. The proportion of trees in each size class observed in reproductive condition increased with size class (see Figure 5).

Table 2. Number of *D. stevensonii* trees monitored in each size class.

Size Class (DBH)	5-10cm	11-20cm	21-30cm	31-40cm	41-50cm
Number of Trees	9	41	35	11	4

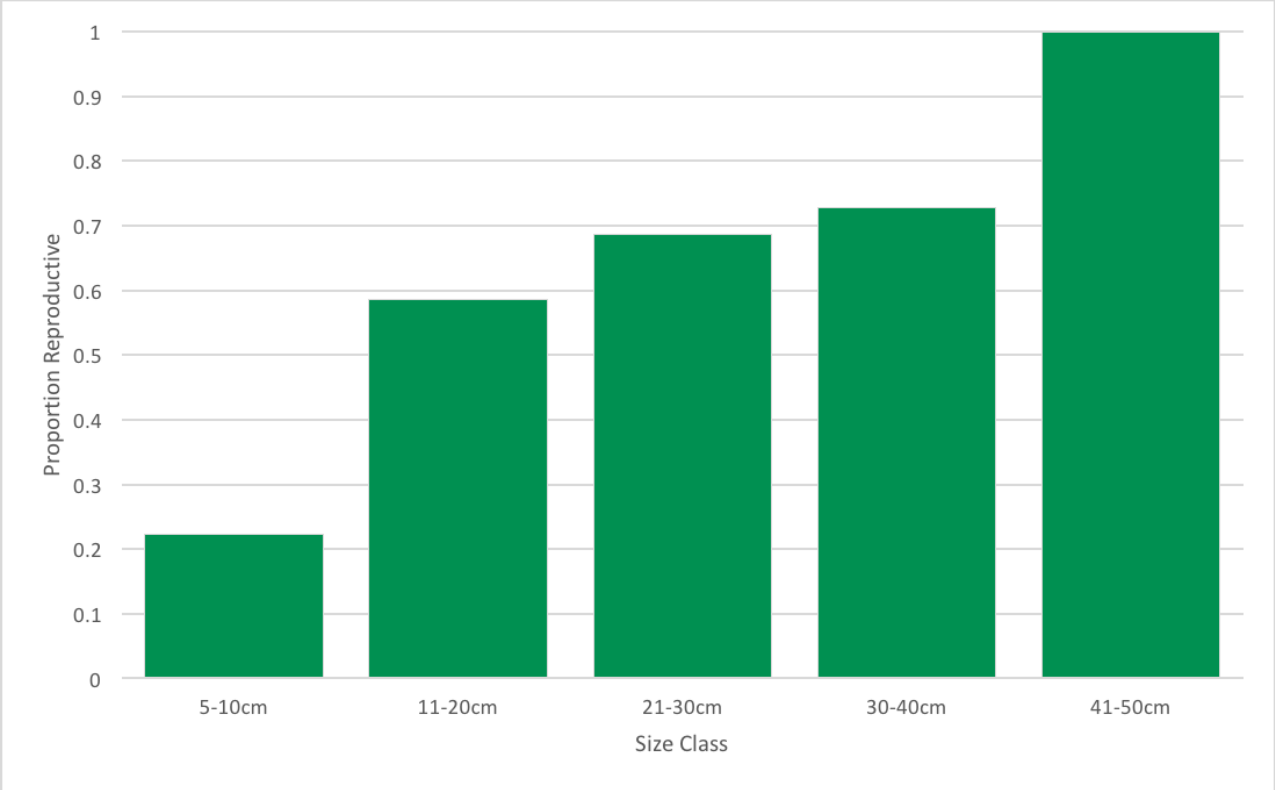

Figure 5. Proportion of each size class found either fruiting or flowering at least once between October 2013 and March 2016.

Timing in fruiting and flowering of *D. stevensonii* was relatively consistent between the 4 subgroups monitored as flowering and fruiting appears to peak in particular months (see Table 3). Flowering was most prominent in May and June during the monitoring period and fruiting during July through December.

Table 3. Number of *D. stevensonii* trees flowering and fruiting in each month from 2013-2016.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	Flowering	-	-	-	-	-	-	-	-	-	0	0	0
	Fruiting	-	-	-	-	-	-	-	-	-	0	0	0
2014	Flowering	0	0	0	0	23	6	12	1	1	0	0	0
	Fruiting	0	0	0	0	0	4	17	3	7	7	16	14
2015	Flowering	0	0	3	0	0	21	3	1	0	0	0	0
	Fruiting	4	3	6	1	1	0	7	6	2	3	3	3
2016	Flowering	0	0	0									
	Fruiting	2	1	2									

BNR

The trees in BNR were monitored for a total of 53 days between August 2014 and March 2016, inclusive.

Mortoniella pittieri

All 11 trees monitored were found flowering and fruiting at least once during the monitoring period. This species flowers and fruits during many months over the year. Flowers were observed mainly from March to October and fruits were observed in July to October (see Table 4).

Table 4. Number of *M. pittieri* trees observed fruiting or flowering between August 2014 and March 2016.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	Flowering								1	7	6	4	6
	Fruiting								0	0	5	4	4
2015	Flowering	1	1	9	10	10	9	11	9	5	11	4	3
	Fruiting	0	0	0	0	1	2	6	2	1	11	3	0
2016	Flowering	7	1	11									
	Fruiting	1	0	1									

Cymbopetalum mayanum

Five of the trees were found to be fruiting or flowering at least once during the monitoring period. The sixth tree died during the course of monitoring and was removed from the monitoring trail in July 2015. *C. mayanum* was observed to flower most prominently between April and August and fruit throughout the rest of the year (September through March) (see Table 5).

Table 5. Number of *C. mayanum* trees flowering and fruiting between August 2014 to March 2016.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	Flowering								0	1	0	0	0
	Fruiting								4	4	5	5	5
2015	Flowering	0	0	1	5	5	5	5	5	0	3	1	0
	Fruiting	5	5	5	4	1	1	4	4	5	5	5	5
2016	Flowering	0	0	4									
	Fruiting	4	4	4									

Pouteria amygdalina

Five of the eleven trees were found fruiting or flowering at least once during the monitoring period. *P. amygdalina* was observed to have a very narrow period of flowering and fruiting during 2015. Flowering was largely confined to March through May and fruiting was observed from April to June (see Table 6).

Table 6. Number of *P. amygdalina* trees flowering and fruiting between August 1014 to March 2016.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	Flowering								0	0	0	0	0
	Fruiting								0	0	0	0	0
2015	Flowering	0	0	1	0	2	0	0	0	0	0	0	0
	Fruiting	0	0	0	2	2	3	0	0	0	0	0	0
2016	Flowering	0	0	0									
	Fruiting	1	0	0									

Chiangiodendron mexicanum

None of the trees of this species were found fruiting or flowering during the monitoring period. Only 1 individual was observed to be losing its leaves, a phenological phase often observed before trees flower.

Macrolobium sp.

The monitored individual was not observed to flower or fruit between August 2014 and March 2016.

Platymiscium dimorphandrum

The 2 individuals were added to the phenology trail in July 2015, and were not observed to fruit or flower between that time and March 2016. Both individuals were found to be losing their leaves in March of 2016, indicating that they may flower and fruit during subsequent monitoring.

Conclusions and Recommendations

The *D. stevensonii* monitored in GSCP was observed to have a single main flowering period during the year, between May and June, while fruiting extends during the rainy season from July - December. This is consistent with other observations and collections made on *D. stevensonii* in Toledo, which were observed to flower in May and June and predicted to fruit in July and August (Stott, 2014). This narrow phenological patterning may indicate that climatic patterns play a significant role in the phenology of this species. The species appears to set flower towards the end of the dry season and fruit when the rainy season begins. It is recommended that the monitoring of these trees be continued to further assess patterns between years. Previous reports indicate that *D. stevensonii* observed in the Chiquibul Forest Reserve may exhibit reproductive activity up to a month before those in Toledo (Stott, 2014). Additional long-term monitoring in that area would provide valuable information regarding the phenological effect of climate patterns in different parts of Belize.

The larger size classes, starting at 11cm DBH, all show more than 50% of trees in a reproductive state. This indicates the importance of maintaining standing individuals of a larger sizes to act as seed trees for natural regeneration. In the greatest class size, 41-50cm DBH, 100% of the monitored trees were fruiting and flowering. While the sample size for this group is small (n=4), the high proportion of reproductive individuals may be indicative of the

importance of large trees as reproductive individuals. Continued monitoring of the reproductive success of frequently fruiting trees of various size classes is recommended to further understand the reproductive biology, particularly in a genus known for mass flowering and high levels of seed abortion. An investigation into whether size class plays a role in the production of viable seeds would be useful in determining harvestable size limits.

The trees in Bladen Nature Reserve are monitored to improve information on the reproductive ecology of each species. As these species may be known to be rare, monitoring reproductive ability may contribute to an understanding of what contributes to that rarity.

Mortoniella pittieri appears to have multiple flowering events sporadically throughout the year, which peak in the dry season. Observations made during surveys suggest that reproductive success may be driven more by the seeds' requirements for germination and light availability for recruitment from seedling to adult than the fruiting capacity of the species (Brewer and Stott, 2014). This species is known for having a relatively narrow habitat specificity; therefore, ensuring the protection of preferred habitat, such as that in BNR, is important for the continued presence of this species in Belize.

Cymbopetalum mayanum was also observed to flower and fruit in multiple events during the year. The flowering peaks towards the end of the dry season and into the wet season. The fruits of this species are known to be an important food source for migratory birds visiting these trees in Mexico (Foster, 2007) and as a common species in BNR, it is likely an important food source for birds of that area as well.

Pouteria amygdalina was very rarely observed to flower and fruit during the monitoring period. However, seeds were collected from the monitored trees and have been successfully propagated in the Ya'axché nursery, indicating viable reproduction in these individuals. The species is abundant on limestone slopes and ridges within BNR. The species is known to be geographically restricted, occurring in Belize; Petén, Guatemala; and Campeche, Mexico. This makes the individuals within Belize potentially very important to the conservation of the species as a whole. Continued monitoring of the individuals in BNR is recommended to assess if the narrow period of flowering and fruiting is typical between years in this species.

None of the individuals of *Chiangiodendron mexicanum* were observed to flower or fruit during the monitoring period. The flowers of this species are very small (less than half a centimetre in length), therefore, flowers may be difficult to distinguish on the branches when observing from the ground. Voucher collections from these individuals could be made to further assess whether they are flowering and fruiting as this would allow a closer assessment of the branches. Observations and collections made outside of Belize suggest the species flowers in April and May and fruits in September and October. The individuals located during surveys in BNR are highly clumped, which may suggest dispersal limitations (Brewer and Stott, 2014). Further monitoring of the species as well as possible propagation trials of seeds, if found, are recommended for this rare and unique species.

The individual of *Macrolobium sp.*, a potentially new species to science, has been monitored to observe flowering and fruiting, which will aid in its identification. As this individual has not yet been observed to have been flowering or fruiting, continued monitoring is required. The individual monitored is an emergent canopy tree, approximately 40m tall, therefore observing phenology from the ground may be difficult. As the observed individual is present on the lower part of a slope, using a more powerful scope from higher up the slope may be useful.

The two individuals of *P. dimorphandrum* in BNR have not yet been monitored for a complete year. Continued monitoring is required as the species is predicted to flower soon after the monitoring period reported here and to observe between-year variations in phenology. Observations from other individuals in Belize indicate fruiting from April until June. From surveys conducted in 2014 and 2015 the species is known to be most abundant in riparian areas of BNR. Recruitment seems to be strongly facilitated by disturbance similar to other wind-dispersed species such as *M. pittieri* and Mahogany species (Brewer and Stott, 2014; Brewer, 2015).

Clarification of the *Platymiscium* species which is harvested in Belize, *P. dimorphandrum* or *P. yucatanum*, is required as observations by researchers have been made that *P. yucatanum* may not be present in Belize (pers. comm. S. Brewer, 2015), yet this species is identified as a species harvestable under permit in the Forest Act (Belize Forest Act 2000). This clarification is particularly pressing as the harvesting of *Platymiscium* species in Belize is believed to be on the rise. Clarification of the species' presence in Belize, along with phenological data can contribute to the creation of a sustainable management plan.

Research and monitoring of both timber and non-timber species provides Belize with valuable information to contribute to the management and conservation of its rare and threatened tree species. Insight into phenological patterns can provide recommendations for management issues such as natural regeneration as well as contribute to hypotheses regarding limitations to species persistence. The information gathered over the course of this monitoring has provided a foundation of ecological information on these species, and Ya'axché plans to continue botanical monitoring in order to contribute to policies and actions intended to preserve the diversity of tree species in Belize.

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